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NRL Report 5833

ATMOSPHERIC ELECTRICITY MEASUREMENTS IN THE NORTH ATLANTIC DURING FALLEX-60

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ABSTRACT

An atmospheric electricity station was installed aboard the USS NORTHAMPTON in August 1960 and was operated during the fall NATO exercises by NRL personnel. The instrumentation proved to be completely seaworthy. The electric field meter was not sufficiently sensitive in this installation to give usable data, hence this study was restricted to measurements with the atmospheric conductivity meter. The behavior of the conductivity measurements was analyzed for the five occasions when fog was encountered; it was found that in most cases, as is also true on land, there was a significant decrease in the total atmospheric conductivity some 2 to 6 hours before the actual fog incidence. Indication was not given, however, prior to fog dissipation. Although data are not sufficient at present for definitive conclusions, it appears that atmospheric electric conductivity may be a supplemental tool in fog forecasting.

PROBLEM STATUS

This is an interim report; work on other phases of the problem is continuing.

AUTHORIZATION

NRL Problem A02-15
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INTRODUCTION

The apparent promise shown by the measurements of atmospheric electrical parameters in contributing to short term fog forecasts on land (1,2) raised the question of the applicability of this principle in oceanic environments. The gracious cooperation of the Commander, Second Fleet, and the Commanding Officer, USS NORTHAMPTON, enabled NRL to install instrumentation similar to that presently used in shore installations (3), aboard this ship. The sensing elements were mounted on the 05 bridge well, forward of the stacks. The layout of the available space precluded the use of the standard housings; so special hoods and shields were fabricated to conform to this location.

This installation is shown in Fig. 1. The stovepipelike chimney is the intake for the Gerdien conductivity chamber, and the electric field meter head extends outboard of the rail. The conductivity chamber intake was baffled to exclude salt spray, and the electrometer head was shock mounted inside a weatherproof enclosure. Since it was anticipated that this apparatus would be manned by NRL scientists, the electric field meter was equipped only with manual calibration hardware. This is not shown in the photograph, but consists of a spring-loaded insulated plate which could be positioned from within the bulkhead, allowing calibrations to be conducted in all types of weather.

The amplifier console was placed in an office as near to the electrometer head location as possible. The recorder was located in the meteorological office, which was well aft of head location. Both the amplifiers and the recorder are identical to those previously

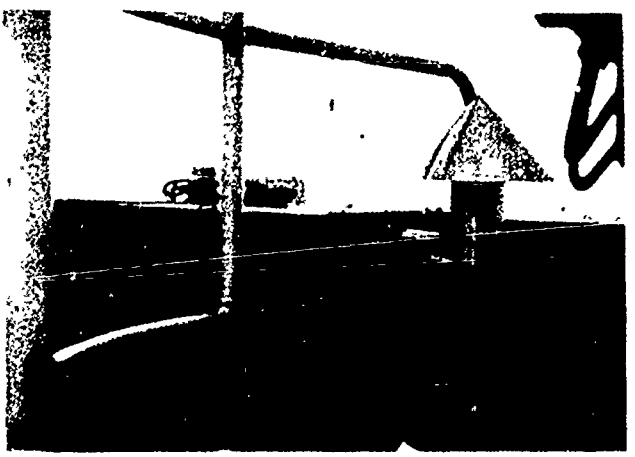

Fig. 1 - The instrumentation aboard the USS NORTHAMPTON

described (3). It was found necessary to shock mount both the amplifier console and the recorder to insure their reliable operation during periods of gunnery practice.

DATA

This station was operated from August through October 1960, and the data here reported were taken between Norfolk, Virginia, and Portsmouth, England, from September 6 to October 2, 1960. It was found that the electric field meter had insufficient sensitivity to provide an adequate recording from the sensor location which was employed; these data are not further considered. The conductivity results were first analyzed for any significant fair weather diurnal variations in order to establish a rough norm for fair weather observations. In so doing, all readings taken less than 4 hours prior to the onset of a fog and less than 2 hours after its dissipation were excluded as were all observations taken during precipitation. From the results of this analysis, shown in Fig. 2, it is seen that there are no significant variations throughout the "average" day.

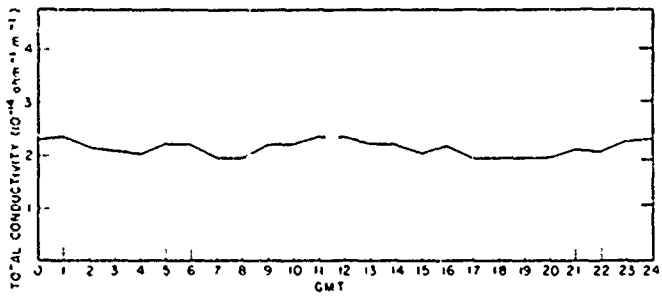

Fig. 2 - Hourly average of the total atmospheric electric conductivity during fair weather from September 6 to October 2, 1960, measured on a cruise from Norfolk to Portsmouth, England

An examination of the meteorological observations taken during the Norfolk to Portsmouth cruise revealed that fog in some form was encountered five times. Figure 3 shows the total conductivity measured before, during, and after the first fog occurrence, on September 9-10, 1960. The duration of the fog was from 0045 to 0530 on the 10th. A significant decrease in the total conductivity commenced about 1500 on the 9th, and a second decrease began about 2000 of the same day. It should be noted that there was no significant increase in the conductivity until the fog had begun to dissipate between 0500 and 0600 on the 10th.

The second fog incident is shown in Fig. 4, which includes data between 0300 September 17 and 1100 September 18. A significant decrease in the conductivity level is to be seen between 0800 and 1000 on the 17th. Again, it is seen that no reliable prediction is given for the dissipation of the fog condition.

Fog was again encountered on the 19th of September, and data gathered on this day are shown in Fig. 5. The break in the line between 1600 and 1800 represents an instrumentation failure caused by a defective relay. Without this data, an accurate analysis of the event is impossible; but there was a noticeable decrease prior to the fog.

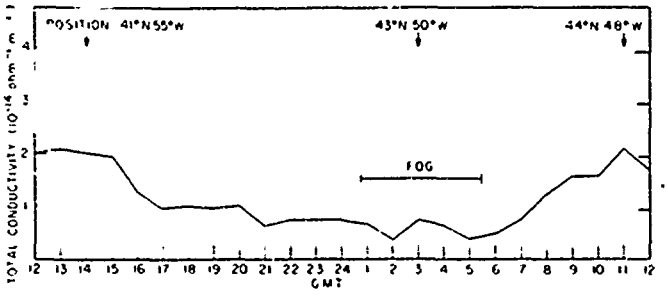

Fig. 3 - Fog incident of September 9-10

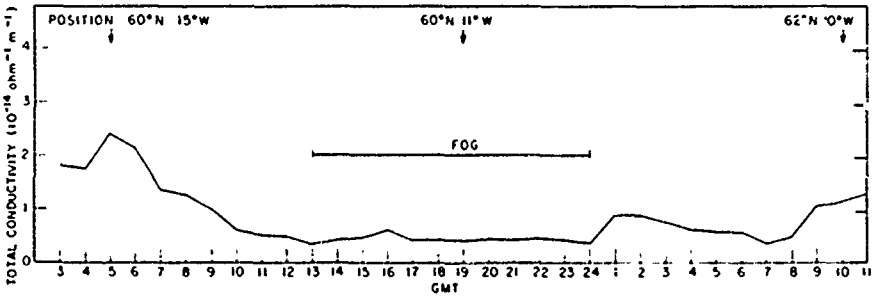

Fig. 4 - Fog incident of September 17-18

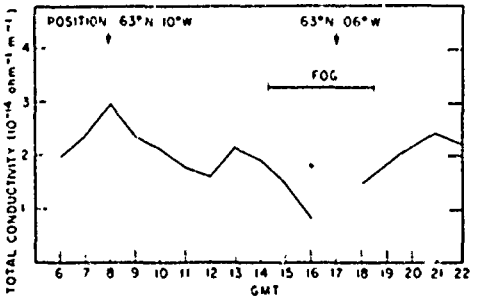

Fig. 5 - Fog incident of September 19

The situation on September 20 shown in Fig. 6 deserves some special mention. The ship itself was in a dense fog between 2000 on the 20th and 0400 on the 21st. The decrease in conductivity between 1200 and 1500 certainly gave an obvious warning of this condition. This must be tempered, however, with the fact that a fog bank was visible a few miles astern and to the port of the ship from about 1430 until 2000. This fog bank did not preclude aircraft operations from carriers that were in the task force, but it did render them relatively difficult. It should be noted that the fog bank and the task force were moving at essentially equal velocities during this period; so the ship was probably relatively stationary in the air mass.

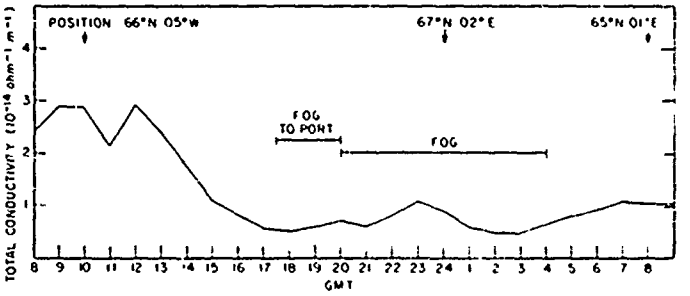

Fig. 6 - Fog incident of September 20-21

The last fog encountered on the cruise occurred on September 22 and is shown in Fig. 7 to be two brief observations in the morning. The observed visibilities in the fog were 4 and 6 miles at 0500 and 0800 respectively. The total conductivity had been extraordinarily low throughout the 21st and continued so on the 22nd. The short duration and mild nature of these fog incidents and the generally low conductivity during the period preclude any definitive analysis, although the abnormally low conductivity level would indicate that conditions were at least conducive to the formation of fog.

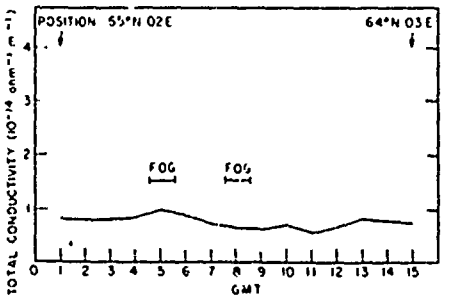

Fig. 7 - Fog incident of September 22

DISCUSSION

This operation had been undertaken in an attempt to determine whether electrical measurements exhibited the same behavior patterns prior to fog at sea as they do on land and to evaluate the reliability of presently used instrumentation in operation on board a

ship at sea. The excellent reliability obtained from instrumentation so hastily prepared and installed as this indicates that no difficulties at all should be encountered in a more carefully prepared installation. It was found that the critical electrometer insulating surfaces did not require cleaning while at sea; in fact, time spent at dockside had a greater detrimental effect than did time at sea.

Examination of the data does indicate that there is, in general, a decrease in the level of total atmospheric conductivity in advance of the onset of fog, as also occurs on land. The present data, however, unlike on land, indicate that little or no indication is given to predict the dissipation of such fog conditions. It seems reasonable to suppose that, since the ship was moving and there is insufficient information regarding the relative speed of the ship and the characteristics of the air mass, there could be a correction in the length of time between the changing trend in conductivity and the onset or dissipation of fog. It must be emphasized that under no circumstances should a conductivity meter be considered to be a black-box fog meter, but only that, at best, it may prove to be a supplemental tool which, in addition to normal meteorological techniques, could increase forecasting effectiveness. Further, it should be remembered that at present the data is so sparse that definitive conclusions cannot be drawn.

ACKNOWLEDGMENTS

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